Egg size, weight and fresh egg density of the Scaly-sided Merganser *Mergus squamatus* in South Primorye, Russia

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Abstract

Egg biometrics data were collected in 2003–2007 in the core breeding area of the Scaly-sided Merganser *Mergus squamatus* in South Primorye, Russia. Mean egg length was 62.5 mm (s.e. ± 0.1 mm) and mean maximum diameter was 44.7 mm (± 0.1). Data on fresh egg weight and density for the Scaly-sided Merganser are published for the first time; fresh egg weight was 70.7 g (± 0.9) and density was 0.56 g/cc (± 0.002). The mass of a full clutch equates to ~76.7% of the female's body mass before egg-laying, and an average Scaly-sided Merganser egg weighs ~7.2% of the female's body mass before egg-laying.

Key words: egg density, egg dimensions, egg weight, investment in egg-laying, Scaly-sided Merganser, South Primorye.

The Scaly-sided Merganser *Mergus squamatus* is one of the rarest seaducks in Asia; it is included in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2006), and also in the Red Data Books of Russia, China and South Korea. Recent estimates of world population size range from 4,500–10,000 individuals (BirdLife International 2001; Shokhrin & Solovieva 2002). The species breeds in a restricted area in southeast Russia and northeast China, and spends the winter in fresh water habitats in China. Most of the breeding population occurs in the Primorye and Khabarovsk regions of Far East Russia (BirdLife International 2001).

The breeding biology of the species has been studied at two major locations – South Primorye, southeast Russia (mainly the Kievka River basin, Lazovskiy State Reserve), and the Changbai Mountains, northeast China (Kolomiytsev 1992; Zhao *et al.* 1995). This paper presents data on egg dimensions, fresh egg weight and fresh egg density from the first of these locations and compares the results with the observations made in previous studies, including in China. Additionally, the level of investment by individual females in egg production is assessed.

Methods

Study Area

Eggs from nests in natural and artificial cavities were measured during the 2003–2007 breeding seasons in South Primorye. The study area included medium sized rivers on the eastern and western slopes of the Sikhote-Alin' Range (Fig. 1). Between 2000–2004, 140 artificial nests were placed along the Avvakumovka, Kievka, Margaritovka, Pavlovka and Iman Rivers and some of their tributaries. Artificial nests were occupied by Scaly-sided Mergansers on the Avvakumovka, Kievka, Margaritovka and Pavlovka Rivers. Rivers ranged from 80–300 km long and their riparian zones were covered mainly by second growth broadleaf forests, fields, roads and villages.

Egg measurements and aging

Egg length and maximum diameter was measured with calipers to the nearest 0.1 mm. Egg volume (cc) was calculated as length x max diameter^2/1,000 and the egg form index (*i.e.* whether or not the egg was elongated in shape) as 100 x max diameter/length (Romanoff & Romanoff 1949). Egg density was calculated as the ratio of egg weight to its volume. Each egg was floated to determine the stage of incubation reached and thus the age of the egg. The mass of fresh, un-incubated eggs was determined to the nearest 0.5 g using a Persola balance with a scale measuring up to 100 g. Eggs found to be at an earlier incubation stage than those in the rest of the clutch were considered to have been dumped by another female and were excluded on recording the clutch size for individual birds. Nest parasitism in Scaly-sided Mergansers will be considered in a separate paper. Incomplete clutches were identified by revisiting the nest to determine whether the clutch size had increased, the eggs having been numbered on first visiting the site.

Catching

Adult Scaly-sided Mergansers were caught using mist-nets at the rivers used for breeding, and on the run-off channels from these rivers, in 2003–2008. Catches were made over a 2–3 week period from late March to mid April, shortly after the birds had arrived on the breeding grounds, during the pre-nesting and clutch initiation period for Scaly-sided Mergansers. Each bird was fitted with a colour-coded leg ring for subsequent identification, and then weighed to the nearest 10 g using a Persola balance to determine their body mass at the start of the breeding season.

Statistical analysis

Mean values are given with standard errors throughout. The coefficient of variation was used to compare egg dimensions within and between clutches, calculated as the ratio of the standard deviation to the mean and expressed as a percentage:

$$CV = s.d./\bar{x} \times 100.$$

Analysis of variance was used to test whether variation in egg dimensions were statistically significant.

Results

A total of 367 eggs were measured from 39 clutches (Table 1). Mean egg length was 62.5

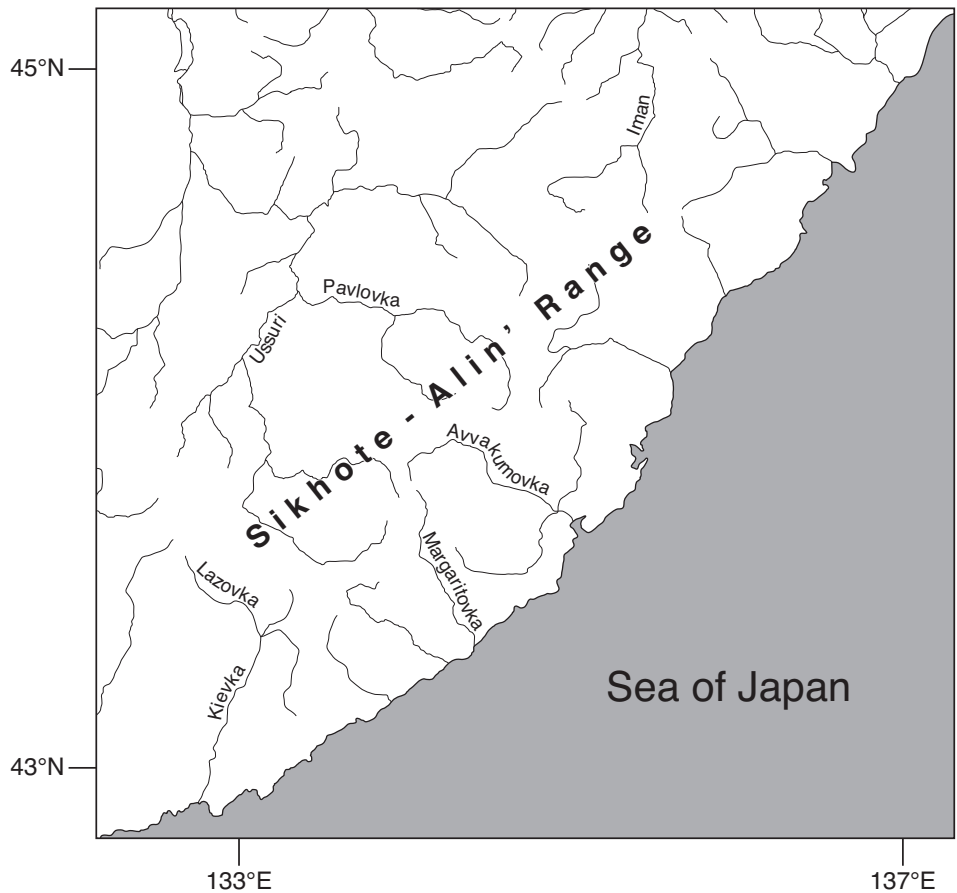

Figure 1. Rivers where artificial nests were put in place for Scaly-sided Mergansers in the southern part of the Primorye region, Russia.

± 0.10 mm and the mean maximum diameter was 44.7 ± 0.06 mm. Variation in egg size was significantly less within clutches than between clutches, both for length (CV = 2.27% and 3.17% respectively, $n = 30$ complete clutches; ANOVA $F_{29,308} = 8.91$, $P < 0.001$) and diameter (CV = 1.63% and 2.42% respectively, $n = 30$; ANOVA $F_{29,308} = 9.15$, $P < 0.001$). These egg dimensions were similar to measurements made of Scaly-sided Merganser eggs in the same study area during the late 1980s, but appeared to be smaller than for eggs measured in the Changbai Mountains, northeast China (Table 2).

Mean egg mass was 70.7 ± 0.9 g and mean density 0.561 ± 0.002 g/cc ($n = 51$ eggs from 11 incomplete clutches, where the eggs were known to be fresh; Table 3). As for egg dimensions, the variation in CV

Table 1. Egg dimensions (n = 367 eggs from 39 clutches) recorded for Scaly-sided Merganser in South Primorye, Russia.

	Mean (± s.e)	Range
Length (mm)	62.5 (0.10)	55.3–68.3
Max. diameter (mm)	44.7 (0.06)	40.3–47.8
Volume (cc)	124.9 (0.40)	96.1–144.5
Egg form index	71.6 (0.10)	63.0–79.1

Table 2. Egg dimensions of the Scaly-sided Merganser from different study areas. Source 1 = Zhao *et al.* (1995), 2 = Kolomiytsev (1992), 3 = this paper. The earlier studies did not report s.e. values, so it was not possible to analyse variation in egg dimensions across sites.

Length, mm		Max diameter, mm		No. of eggs	Location	Source
Mean (s.e)	**Range**	**Mean (s.e)**	**Range**			
63.3	62.0– 66.4	45.9	45.0–47.2	21	Changbai Mountains	1
62.7	56.7–67.6	44.7	42.8–46.8	89	South Primorye	2
62.5 (0.1)	55.3–68.3	44.7 (0.1)	40.3–47.8	367	South Primorye	3

fresh egg mass was significantly less within clutches than between clutches for five incomplete clutches found with more than four eggs (2.82% and 8.73% respectively; ANOVA $F_{5,32} = 4.79$, $P < 0.01$).

Between 2001 and 2008, eight females were caught before starting to lay eggs; the average body mass of these females was 977 ± 18 g (range: 930–1,070 g). The average number of eggs laid by an individual female was 10.6 ± 0.3 eggs (range: 7–16 eggs, n = 37 clutches) and the mass of an average clutch was 749 g (mean = 10.6 eggs, weighing on average 70.7 g each). Thus the mass of a full clutch equates to ~76.7% of the female's body mass and an average Scaly-sided Merganser egg weighs ~7.2% of the female's body mass before egg-laying.

Three females caught before or during egg-laying were subsequently recaptured at their nest sites later in the season, making it possible to determine their individual investment in clutch production (Table 4). Two of the females (ring codes 6379 and 8566) were first caught before they started to lay eggs. Their clutches of 11 and 9 eggs, respectively, represented 72.7% and 63.1% of their pre-laying body mass. The third

Table 3. Weight, volume, density and dimensions of fresh Scaly-sided Merganser eggs (n = 51 eggs from 11 incomplete clutches; mean = 4.63 eggs/nest, range = 1–11 eggs/nest) found in South Primorye, Russia.

	Mean (± s.e)	Range
Length (mm)	63.3 (0.31)	57.7–68.2
Max. diameter (mm)	44.6 (0.23)	40.8–47.8
Weight (g)	70.7 (0.90)	56–80
Volume (cc)	126.0 (1.70)	97.2–144.5
Density (g/cc)	0.561 (0.002)	0.537–0.584

Table 4. Individual investment in laying a clutch by three female Scaly-sided Mergansers.

Female identity no.	Capture date	Female body mass (g)	Onset of laying[1]	No. eggs laid	Mean fresh egg mass (g)	Clutch mass (g)	Clutch mass in relation to female body mass (%)
6379	31/03/2003	1,010	01/04/2003	11	66.8	735	72.7
7502	05/04/2004	890	26/03/2004	12	68.4	821	92.2
8566	04/04/2008	960	07/04/2008	9	67.3	606	63.1

[1] Onset of laying was calculated from the number of eggs found in the clutch on the basis of one egg being laid every 36 h, where the age of the clutch was also known.

female (ring code 7502) was caught nine days after she had started to lay, by which time she had produced 5–6 eggs, and the mass of the clutch equated with 92.2% of her body mass at that time.

Discussion

Data on Scaly-sided Merganser egg dimensions have previously been reported for the isolated breeding population in the Changbai Mountains, northeast China, and also for the South Primorye population (Kolomiytsev 1992; Zhao *et al.* 1995), but data on fresh egg weight and egg density are published here for the first time. Our egg dimensions data were very similar to those of Kolomiytsev (1992), who presented data from 1986–89 from the same study area. Eggs from the Changbai Mountains were slightly larger both in length and in maximum diameter than the eggs in our study; however, this may be due to the small sample size from China. The 21 eggs

measured in China seemingly belonged to two complete clutches, whereas the egg dimensions data presented here were derived from 39 clutches.

Two individual females caught before egg laying and later in the season on the nest (ring codes 6379 and 8566) appeared to invest less energy in egg production (measured as the mass of the clutch, as a function of the female's body mass) than the average investment calculated for female Scaly-sided Mergansers. This may be explained by their eggs weighing less than average (mean egg weight = 66.8 g and 67.3 g respectively for the two females, compared with 70.7 g for all clutches recorded) and also by a small clutch size of nine eggs recorded for female No. 8566. The third female (ring code 7502), caught after having laid a half clutch, was relatively light compared with the mass of her clutch at that time, given that the mass of the full clutch equated to 92.2% of her mid-laying body mass. Further data is required for a full analysis of variation in individual investment in egg-laying for the species, and the consequences of this both for female survival rates and for the survival of the ducklings.

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